

CLAIMS

CLAIMS

1. A charge pump type DC/DC converter having the following:
 - a voltage input terminal connected to the output terminal of a DC power supply;
 - first and second capacitors;
 - a voltage output terminal connected to a load;
 - a switch circuit network having a first phase, in which a first terminal of the aforementioned first capacitor is connected to the aforementioned voltage input terminal, a first terminal of the aforementioned second capacitor is connected to the aforementioned voltage output terminal, and a second terminal of the first capacitor and a second terminal of the second capacitor are connected to each other, and a second phase, in which the first and second terminals of the aforementioned first capacitor are connected to the aforementioned voltage output terminal and the voltage input terminal, respectively, and the first and second terminals of the second capacitor are connected to the aforementioned voltage input terminal and a reference potential, respectively; and
 - a switching control means that controls the aforementioned switch circuit network to switch the aforementioned first and second phases alternately at prescribed duty ratios.
2. The DC/DC converter described in Claim 1 characterized by the fact that the first capacitor is a one capacitor element.
3. The DC/DC converter described in Claim 2 characterized by the fact that the capacitance of the first capacitor is approximately equal to that of the second capacitor.
4. The DC/DC converter described in any of Claims 1-3 characterized by the fact that the duty ratios of the aforementioned first and second phases are set at about $\frac{1}{2}$.
5. The DC/DC converter described in any of Claims 1-4 characterized by the following facts:
 - the aforementioned switch circuit network has the following:
 - a first MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the first terminal of the aforementioned first capacitor;

a second MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the second terminal of the aforementioned first capacitor;

a third MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the first terminal of the aforementioned second capacitor;

a fourth MOS transistor with a first terminal connected to the second terminal of the aforementioned first capacitor and a second terminal connected to the second terminal of the aforementioned second capacitor;

a fifth MOS transistor with a first terminal connected to the second terminal of the aforementioned second capacitor and a second terminal connected to the aforementioned reference potential;

a sixth MOS transistor with a first terminal connected to the first terminal of the aforementioned first capacitor and a second terminal connected to the aforementioned voltage output terminal; and

a seventh MOS transistor with a first terminal connected to the first terminal of the aforementioned second capacitor and a second terminal connected to the aforementioned voltage output terminal;

the aforementioned switching control means controls as follows:

in the first phase, the aforementioned first, fourth, and seventh MOS transistors are kept in the on state, and the aforementioned second, third, fifth, and sixth MOS transistors are kept in the off state;

in the second phase, the aforementioned first, fourth, and seventh MOS transistors are kept in the off state, and the aforementioned second, third, fifth, and sixth MOS transistors are kept in the on state.

6. The DC/DC converter described in Claim 1 characterized by the fact that the aforementioned first capacitor is comprised of n (n is an integer of 2 or larger) capacitor elements, the aforementioned n capacitor elements are connected in series in the aforementioned first phase, and the aforementioned n capacitor elements are connected in parallel with each other in the aforementioned second phase.

7. The DC/DC converter described in Claim 6 characterized by the fact that the aforementioned n capacitor elements have approximately the same capacitance.

8. The DC/DC converter described in Claim 6 or 7 characterized by the fact that the duty ratio of the aforementioned first phase is set at about $1/(n+1)$, and the duty ratio of the aforementioned second phase is set at about $n/(n+1)$.

9. The DC/DC converter described in any of Claims 6-8 characterized by the following facts: the aforementioned first capacitor is comprised of first and second capacitor elements; the aforementioned switch circuit network has the following:

- a first MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the first terminal of the aforementioned first capacitor element;

- a second MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the second terminal of the aforementioned first capacitor element;

- a third MOS transistor with a first terminal connected to the second terminal of the aforementioned first capacitor element and a second terminal connected to the first terminal of the aforementioned second capacitor element;

- a fourth MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the second terminal of the aforementioned second capacitor element;

- a fifth MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the first terminal of the aforementioned second capacitor;

- a sixth MOS transistor with a first terminal connected to the second terminal of the aforementioned second capacitor element and a second terminal connected to the second terminal of the aforementioned second capacitor;

- a seventh MOS transistor with a first terminal connected to the second terminal of the aforementioned second capacitor and a second terminal connected to the aforementioned reference potential;

- an eighth MOS transistor with a first terminal connected to the first terminal of the aforementioned first capacitor element and a second terminal connected to the aforementioned voltage output terminal;

- a ninth MOS with a first terminal connected to the first terminal of the aforementioned second capacitor element and a second terminal connected to the aforementioned voltage output terminal; and

a tenth MOS transistor with a first terminal connected to the first terminal of the aforementioned second capacitor and a second terminal connected to the aforementioned voltage output terminal;

the aforementioned switching control means controls as follows:

in the first phase, the first, third, sixth, and tenth MOS transistors are kept in the on state, and the second, fourth, fifth, seventh, eighth, and ninth MOS transistors are kept in the off state;

in the second phase, the first, third, sixth, and tenth MOS transistors are kept in the off state, and the second, fourth, fifth, seventh, eighth, and ninth MOS transistors are kept in the on state.

10. The DC/DC converter described in Claim 1 characterized by the fact that the aforementioned first capacitor is comprised of n (n is an integer of 2 or larger) capacitor elements, the aforementioned n capacitor elements are connected in parallel with each other in the aforementioned first phase, and the aforementioned n capacitor elements are connected in series in the aforementioned second phase.

11. The DC/DC converter described in Claim 10 characterized by the fact that the aforementioned n capacitor elements have approximately the same capacitance.

12. The DC/DC converter described in Claim 10 or 11 characterized by the fact that the duty ratio of the aforementioned first phase is set at about $n/(n+1)$, and the duty ratio of the aforementioned second phase is set at about $1/(n+1)$.

13. The DC/DC converter described in any of Claims 10-12 characterized by the following facts: the aforementioned first capacitor is comprised of first and second capacitor elements; the aforementioned switch circuit network has the following:

a first MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the first terminal of the aforementioned first capacitor element;

a second MOS transistor with a first terminal connected to the second terminal of the first MOS transistor and a second terminal connected to the first terminal of the aforementioned second capacitor element;

a third MOS transistor with a first terminal connected to the second terminal of the aforementioned first capacitor element and a second terminal connected to the first terminal of the aforementioned second capacitor element;

a fourth MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the second terminal of the aforementioned second capacitor element;

a fifth MOS transistor with a first terminal connected to the second terminal of the aforementioned first capacitor element and a second terminal connected to the second terminal of the aforementioned second capacitor element;

a sixth MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the first terminal of the aforementioned second capacitor;

a seventh MOS transistor with a first terminal connected to the second terminal of the aforementioned second capacitor element and a second terminal connected to the second terminal of the aforementioned second capacitor;

an eighth MOS transistor with a first terminal connected to the second terminal of the aforementioned second capacitor and a second terminal connected to the aforementioned reference potential;

a ninth MOS transistor with a first terminal connected to the first terminal of the first capacitor element and a second terminal connected to the aforementioned voltage output terminal; and

a tenth MOS transistor with a first terminal connected to the first terminal of the aforementioned second capacitor and a second terminal connected to the aforementioned voltage output terminal;

the aforementioned switching control means controls as follows:

in the first phase, the aforementioned first, second, fifth, seventh, and tenth MOS transistors are kept in the on state, and the aforementioned third, fourth, sixth, eighth, and ninth MOS transistors are kept in the off state;

in the second phase, the aforementioned first, second, fifth, seventh, and tenth MOS transistors are kept in the off state, and the aforementioned third, fourth, sixth, eighth, and ninth MOS transistors are kept in the on state.

14. The DC/DC converter described in Claim 1 characterized by the following facts: the aforementioned first capacitor is comprised of $n \times m$ (n and m are integers of 2 or larger) capacitor elements; in the first phase, for the aforementioned $n \times m$ capacitor elements, all n capacitor elements are connected in series, and these serial capacitor circuits are connected in parallel in m columns; in the second phase, for the aforementioned $n \times m$ capacitor elements, all m capacitor elements are connected in series, and these serial capacitor circuits are connected in parallel in n columns.

15. The DC/DC converter described in Claim 14 characterized by the fact that the aforementioned $n \times m$ capacitors have approximately the same capacitance.

16. The DC/DC converter described in Claim 14 or 15 characterized by the fact that the duty ratio of the first phase is set at about $m/(n+m)$, and the duty ratio of the aforementioned second phase is set at about $n/(n+m)$.

17. The DC/DC converter described in any of Claims 14-16 characterized by the following facts: the aforementioned first capacitor is comprised of first, second, third, and fourth capacitor elements; the aforementioned switch circuit network has the following:

- a first MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the first terminal of the aforementioned third capacitor element;

- a second MOS transistor with a first terminal connected to the first terminal of the aforementioned third capacitor element and a second terminal connected to the first terminal of the aforementioned first capacitor element;

- a third MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the second terminal of the aforementioned first capacitor element;

- a fourth MOS transistor with a first terminal connected to the second terminal of the aforementioned first capacitor element and a second terminal connected to the first terminal of the aforementioned second capacitor element;

- a fifth MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the second terminal of the aforementioned second capacitor element;

- a sixth MOS transistor with a first terminal connected to the second terminal of the aforementioned third capacitor element and a second terminal connected to the first terminal of the aforementioned fourth capacitor element;

- a seventh MOS transistor with a first terminal connected to the first terminal of the aforementioned first capacitor element and a second terminal connected to the second terminal of the aforementioned third capacitor element;

- an eighth MOS transistor with a first terminal connected to the first terminal of the aforementioned second capacitor element and a second terminal connected to the second terminal of the aforementioned fourth capacitor element;

a ninth MOS transistor with a first terminal connected to the second terminal of the aforementioned second capacitor element and a second terminal connected to the second terminal of the aforementioned fourth capacitor element;

a tenth MOS transistor with a first terminal connected to the aforementioned voltage input terminal and a second terminal connected to the first terminal of the aforementioned second capacitor;

an eleventh MOS transistor with a first terminal connected to the second terminal of the aforementioned fourth capacitor element and a second terminal connected to the second terminal of the aforementioned second capacitor;

a twelfth MOS transistor with a first terminal connected to the second terminal of the aforementioned second capacitor and a second terminal connected to the aforementioned reference potential;

a thirteenth MOS transistor with a first terminal connected to the first terminal of the aforementioned third capacitor element and a second terminal connected to the aforementioned voltage output terminal;

a fourteenth MOS transistor with a first terminal connected to the first terminal of the aforementioned fourth capacitor element and a second terminal connected to the aforementioned voltage output terminal;

a fifteenth MOS transistor with a first terminal connected to the first terminal of the aforementioned second capacitor and a second terminal connected to the aforementioned voltage output terminal;

the switching control means controls as follows:

in the first phase, the first, second, fourth, sixth, ninth, eleventh, and fifteenth MOS transistors are kept in the on state, and the third, fifth, seventh, eighth, tenth, twelfth, thirteenth, and fourteenth MOS transistors are kept in the off state;

in the second phase, the first, second, fourth, sixth, ninth, eleventh, and fifteenth MOS transistors are kept in the off state, and the third, fifth, seventh, eighth, tenth, twelfth, thirteenth, and fourteenth MOS transistors are kept in the on state.

18. The DC/DC converter described in any of Claims 1-17 characterized by having a third capacitor for smoothing with a first terminal connected to the aforementioned voltage output terminal and a second terminal connected to the reference potential.

19. The DC/DC converter described in any of Claims 1-18 characterized by having the following:

a current control circuit that is connected in series between the aforementioned voltage input terminal and the aforementioned first capacitor,

a voltage detecting means used for detecting the output voltage obtained at the aforementioned voltage output terminal,

a reference voltage generating means that can generate a reference voltage corresponding to the set value of the output voltage output from the aforementioned voltage output terminal, and

a current control means that compares the aforementioned output voltage detected by the aforementioned voltage detecting means with the aforementioned reference voltage and controls the current of the aforementioned current control circuit corresponding to the comparison error.

20. The DC/DC converter described in any of Claims 5, 9, 13, 17 characterized by the fact that all of the aforementioned MOS transistors are turned off simultaneously in the phase switching period between the aforementioned first and second phases.